

## ***Interactive comment on “Theoretical study of solar light reflectance from vertical snow surfaces” by O. V. Nikolaeva and A. A. Kokhanovsky***

### **Anonymous Referee #1**

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### **Review comments**

Theoretical study of solar light reflectance from vertical snow surfaces O.V. Nikolaeva and A.A. Kokhanovsky

This paper describes the 2-D model of solar reflectance on a vertical wall of a snow pit. Although I do see the merit of this study I found it not well motivated and not well described/explained. In my view The Cryosphere is a journal for cryospheric science in general, and not a specialised journal for radiation studies and thus a bit more explanation on radiative properties is necessary.

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## General remarks

In addition to the above comments, the authors state that large errors are produced when 1-D RTT is used. However, I am missing a qualitative and quantitative comparison of the 2-D results with 1-D results. It would strengthen the manuscript if such a comparison was added. For example add lines in the figure to describe the 1-D results, or/and show the effect of these different assumptions on the retrieval of e.g. snow grain radii or other snow properties in order to quantify the error.

Although the English is reasonable, the manuscript would benefit greatly from being checked by a native English speaker.

## Specific remarks

### Abstract

- I am missing a clear description of the motivation and goal of this study. - Radiative Transfer Theory is a broad term, be more specific. e.g. I miss the fact that the used theory is 2-D.

- What is meant by '3-D geometries'? Rephrase the sentence.

- I have not found any quantitative or qualitative comparison of the presented 2-D problem with the 1-D problem. In my opinion it is therefore not possible to state that 'large errors are found'.

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## Introduction

- P4206 L25 Explain 1-D transfer theory in one sentence.
- P4106 L26 Explain '3-D effects'.
- P4207 L3-8 You refer to 3-D here while in the manuscript a 2-D problem is described. Please explain that at this point, and why you think that a 3-D problem can be described with a 2-D model? Also explain why this is better than the 1-D description.

## Theory

- P4207 L24 Explain what is meant by symmetry plane.
- P4207 L25 Somewhere at this point you should refer to figure 5 in order to illustrate the geometry of the presented problem.
- P4207 L25 Explain what you mean by radiance (wavelength, direction).
- P4207 L25 Consider using a different font for I. I confused it at first with the division sign '/'. - P4208 Eq1 and further Explain ALL symbols when you introduce them.
- P4208 Eq1 Explain the different terms in the equation.
- P4208 L5 Refer to figure 5 to better explain the different regions in the 2-D problem.
- P4208 Eq2-4 State that the values for the different constants will be defined in section 4.
- P4209 L1 Explain what a perfect Lambertian surface is.
- P4209 Eq5 What is R?
- P4209 L3 Explain where black condition refers to. Is 'right' correct? Shouldn't this be 'left'?
- P4209 L3-6 Order is a bit confusing. The characteristics of the sides of the pit are defined by  $A_s$  as defined by equation 7. Equation 6 is a special case of 7.
- P4209 Eq8 Explain where the factor pi is coming from.
- P4209 L10 Explain why you want to make one or two surfaces black.

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- Explain the effects of the different assumptions you make on the results. For example, you reduce a 3-D problem to 2-D, you assume a diffuse source of size  $S_0$  neglecting the atmosphere, you make the problem completely diffuse while solar radiation has a direct component as well.
- From this section it is not clear what you want to calculate at all. Be more clear what quantity you are looking for.

## Numerical algorithm

- P4210 L2 Explain why the problem described in section 2 should be solved numerically.
- P4210 L3 Where do you define the reflected radiation intensity in section 2? Be consistent with terms you use and explain/introduce them properly.
- P4210 L5 First introduce the quadrature method in 1 or 2 sentences before using it.
- P4210 Eq9 and further, Explain ALL symbols when you introduce them.
- P4211 L1-2 I dont understand this sentence, figure 6 does not provide any information.
- P4211 Eq14 How this this equation relate to the original problem to solve?
- P4212 Eq22-23 Where are these equations based on, on what assumptions?
- P4212 L11 Segment of what? How is this segment defined?
- P4212 L18 What method is referred to in 'This method'?
- P4213 L6 I don't see how equations 14-23 can be presented with equation 27. I see a rewritten version of equation 9.
- P4313 L6 From this point on you lost me. I don't understand the last part of section 3, so please rewrite and explain better.

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## Results

- I suggest to rename this section 'Experimental setup' and start a new section 'Results' on P4215 after line 19.
- P4214 L18 Give the used value for  $H$ .
- P4214 L19 Give the used value for  $D$ .
- P4214 L21  $W_{0air}$  is not a function of  $z$ , but a constant.
- P4214 L23 Give a reference for the geometrical optics theory used.
- P4214 L24 Which functions do you refer to here?
  
- P4215 L13 What measurements? This is all theoretical.
- P4215 L14 Add sentence: 'We define three experiments:'
- P4215 L15-18 I am not sure 'black film' is the most appropriate wording for this. And explain why you want to make the bottom or sides black.
- P4216 L2 Refer to the experiment described in the previous page.
- P4216 L9 At this point you explain why you do this 2-D modelling. This should be explained properly much earlier! The relation of  $I$  with depth in the 1-D case should be added in the figures to illustrate how wrong 1-D actually is. It would also be good to quantify the made error or difference. Furthermore, it would also add to the manuscript when an example is shown of snow radii calculated with the 1 and 2-D model to show the significance of the made error. The problem shown here is 2-D, what is the expected error introduced by limiting the problem to 2-D instead of 3-D?
- P4216 L17 Explain what the center point is, refer to the appropriate figure.
- P4216 L20-22 Rephrase this sentence.
- P4216 L24 Where does 'it' refer to?
- P4217 L1 Explain. To me it is not clear the 1-D models can not be applied, see my remarks above.

## Conclusions

- P4217 L17-18 How do you define significant?

## Figures

- For all figures the captions are not complete. Captions should explain what is shown in the figure. - Figures 1-4 can be reduced to 1 figure.
- Figure 5 is an important figure, explaining the geometry of the problem. But it is not a clear figure. It is not clear where the 0 of the z axis is located, the different view angles in (a) are not clear, and the figure shows half the domain shown in figure 1, 2 and 4, which is confusing.
- Figure 6, I don't see the additional value of this figure.
- Figure 8, geometry is not clear with respect to figure 5 or figure 1. What case is described here? Which sides are left white and which black?
- Figure 9, In (b) I miss the line for the last option in the legend. In the caption explain what deviation is.
- Figure 10, explain the lines/ symbols in (b).
- Figures 9-13 Small figures, please enlarge and make more clear.

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